HEATHROW INTERNATIONAL AIR TRAFFIC CONTROL
for the Amstrad CPC64

INSTRUCTION MANUAL

1. Introduction

Congratulations, you are the proud owner of Heathrow International Air Traffic Control for the Amstrad CPC64, written entirely in machine code for maximum enjoyment.

Your purchase will provide you with hours of fun because it simulates as closely as possible the real-life operation of Air Traffic Control Radar at London Heathrow and Amsterdam Schiphol Airports. You should not expect to understand all the operations immediately - you must first learn the meanings of special words and phrases like localiser, expedition, glide slope and fully established.

To make the most of your cassette as soon as possible you are advised to:-

(a) read all the instructions, particularly sections 3 and 4;

(b) load the cassette and watch the demonstration (level 5);

(c) re-read sections 3 and 4;

(d) re-run level 5 and follow the description of it in section 4.

You should then be ready to progress through the various levels. Eventually you will become fully capable of dealing with any situation and will be able to take charge of Air Traffic Control. The program is designed to simulate the functions of either Heathrow or Schiphol Air Traffic Control. The objective is to land ten aircraft (or as many as possible within the time limit of 30 minutes) as safely as you can. The task is a complex one and has been broken down into a number of levels to enable you to gradually develop your expertise.

2. Loading The Program

Select the side of the tape that you require. Load the program in the usual way. Start the tape at the beginning and wait until you are offered a menu of options on the TV screen, then switch off the tape. The menu consists of a choice of several levels.

3. System Description

In order to understand the Air Traffic Control problem run the demonstration exercise by either pressing 5 or leaving the computer for 40 seconds, after which time the demonstration is selected automatically.

Once into the demonstration the radar screen is displayed together with information on the aircraft. The aircraft arrive at the holding stacks which are radio beacons around which the aircraft fly in a racetrack pattern. Air Traffic Control (ATC) then gives instructions to position the aircraft onto a pair of radio beams, called the ILS (Instrument Landing System) with which the aircraft can complete the landing.

3.1. Radar Screen

The radar screen is the dark rectangle with the holding stacks shown as small white plus signs around which the aircraft (shown as white blocks with a trail of white dots) circle. To identify the stacks select the help pages by pressing any shift key and the "H" key during an exercise, and select the page containing the map. To return to the exercise press 'ENTER'.

As you will see, each stack has a three letter name.

In the centre of the screen are two short thick lines representing Schiphol or Heathrow as the case may be, and on either side are shown the extended centrelines of the landing runways. The small dots on the centrelines are range marks located every two miles. The total length of the centreline is 10 miles either side. There are two parallel runways, one for landing and one for take off. We are concerned only with the landing runway.

The landing runway varies with the wind direction as aircraft prefer to land into the wind. Note that at Schiphol the centreline of the landing runway only is shown whereas at Heathrow both of the parallel runways are shown, the landing runway being the top line in each direction.

Wind direction	**Direction of landing**	**Runway**
Schiphol Northerlies	Bottom to top	01R
Schiphol Southerlies	Top to bottom	19R
Heathrow Westerlies	Right to left	28R
Heathrow Easterlies	Left to right	10L

As the demonstration progresses the aircraft circle around the stacks. Above or to the right of each aircraft is a label produced by the Secondary Surveillance Radar (SSR). This label consists of a one letter call sign of the aircraft and one digit showing the altitude of the aircraft in thousands of feet, rounded down to the nearest thousand feet, e.g. A6 means aircraft A at an altitude between 6000 and 6999 feet. Labels are only displayed on aircraft below 8000 feet

and only inbound aircraft are controlled and labelled. Outbound aircraft are marked with the altitude only.

3.2 Stack Display

To the right of the radar screen is the stack display. This shows information about each aircraft from the time it first appears on the radar until it lands. It is divided into sections (one on top of the other), one for each of the holding stacks (the appropriate 3 letter designator being printed beside each section). It is also divided into 3 vertical columns, the left hand section contains aircraft identity (one capital letter) followed by the aircraft type (one small letter) followed by the altitude to which it has been cleared by ATC. The aircraft type can be one of five types: c for concorde, h for heavy jet (such as Boeing 747), m for medium jet (such as Douglas DC9), s for small propellor driven airliner (such as Fokker F27) and l for light aircarft (such as Navajo).

The second vertical column contains the aircraft heading or other direction information e.g. 'H' = Holding at stack, 'loc' = localiser established, 'EST' = fully established. Aircraft heading is the direction in which an aircraft is flying measured in compass degrees i.e. 360 degrees = North, 270 degrees = West, 130 degrees = South East etc. (direction on the radar screen is aligned such that North points straight up). The third vertical column contains the aircraft speed in nautical miles per hour. To assist in identifying items in

the stack display the columns are headed with 'Ac' for the aircraft name, 'L' for altitude, 'Hd' for heading and 'Sp' for speed. Above the stack display wind information is given measured in compass degrees (the direction from which the wind is blowing), followed by the speed in knots e.g. wind 240/20 means a wind from the south west at 20 knots.

3.3 Radio Communication

On the left hand side, above the radar screen in the box marked RT, is the equivalent to radio communication. You can send instructions to aircraft using the keyboard. As you press each key the appropriate symbol will appear. Instructions have the format: aircraft identity (1 letter), instruction type (**input the first letter** and the whole word will be printed), appropriate parameter (letter or numbers).

The instructions accepted are:-

Altitude - followed by one number (ENTER), will instruct the aircraft to climb or descend to the altitude entered. (The number being the number of thousands of feet e.g. A Altitude » 3 means aircraft A climb or descend to 3000 feet). You may only input altitudes 2 - 9, 2000 feet is the lowest safe altitude, 9000 feet is the top of your airspace. Any error in this will give the response "BAD ALT" (Bad Altitude). The rate at which an aircraft will climb or descent depends upon the aircraft type, i.e. l/s aircraft climb and descend slower than m/h/c aircraft.

Once an instruction has been typed in, press ENTER. If the instruction is acceptable it will

move down one line and the word "ROGER" will appear after it meaning "message received and understood". If you make a mistake and wish to retype the instruction prior to entering, press DEL to delete the instruction.

"Left":- This is a heading change instruction telling an aircraft to turn left to the heading designated after the word 'Left' e.g. A Left » 240 means aircraft A to turn from its present heading onto heading 240 degrees with a left turn. It takes some practice to visualise whether a turn is to the left or right, especially when aircraft are not flying 'up' the radar screen. Any value of heading input will be rounded down to the nearest 10 degrees. Note: Headings must be input using three digits, e.g. 090, not 90, etc.

"Right":- a heading change instruction telling an aircraft to turn right to the designated heading.

"Maintain":- instructs an aircraft to continue flying on whatever heading the aircraft is on or passing at the time.

"Orbit":- instructs an aircraft to circle once onto the heading that the aircraft was on at the time. If the aircraft is already turning it will continue to turn to the last instructed heading. Direction of the turn will be to the left unless the instruction is appended by R.

"Speed":- this tells an aircraft to adjust speed to the specified speed e.g. C Speed » 200 means aircraft C adjust speed to 200 knots.

The different types of aircraft have different speed ranges over which they may fly. If you input a speed not possible for that particular

aircraft or make some other error on entry you will get the response "BAD SPC" (Bad Speed).

aircraft types	maximum speed	minimum speed	ILS max speed
l	180 kts	120 kts	160 kts
s	210 kts	140 kts	180 kts
m	250 kts	160 kts	200 kts
h	250 kts	160 kts	200 kts
c	300 kts	190 kts	230 kts

Speeds when input are rounded down to the nearest 10 kts.

"Quote":- this is an enquiry to an aircraft followed by one letter which specifies the information that is required. The information appears in the space normally occupied by the message 'roger'. The letter 'A' returns a value of the aircraft altitude in thousands of feet e.g. A Quote » A might return a value 3.8 meaning aircraft A altitude = 3,800 feet. The letter 'H' returns the aircraft heading, and 'S' the speed. If a letter is input that is not recognised you will get the response "REPEAT" inviting you to re-input the enquiry with the correct letter.
If you get the response of a blank red area, this means that you have addressed an aircraft that is not under you control (either not yet on the radar, already landed or overshooting).
Above the radar is a yellow line awaiting any relevant incoming messages. When messages come in you will see the line flash until the message is acknowledged by pressing the "BREAK/space" key.

Certain of the keys have special functions:-

"**SPACEBAR**" :- acknowledges incoming messages (you will get no further messages until each message is acknowledged, in turn).

"**ENTER**":- used for evaluating instructions.

"**DEL**":- deletes the line of instruction currently being typed.

"←":- :- freezes the exercise and waits until key "ENTER" is pressed.

"↓":- changes the update rate to real time.

"↑":- changes the update rate to a rate faster than real time.

"**COPY**":- holds the exercise and displays a page of information containing an assessment of your performance to date (based on average landing interval, expedition, safety and, if applicable, emergency handling - you need 70% to pass).

"**Shift** + **X**":- abandons the exercise and returns to the Menu.

"**Shift** + **R**":- illuminates the Radar Manoeuvring area.

'**Shift** + **H**":- gives a set of Help pages.

Expedition marks are dependent upon 1) the time it takes to land the first aircraft (the sooner the better); 2) the average landing interval (the smaller the better) and 3) the number of aircraft landed (the more the better).

Beneath the assessment is a series of pages of significant events. Key 'M' gives a new page of events, at the end of all events you are given the prompt "Press ENTER TO RETURN" which is the key to return you to the exercise.

4. Demonstration Exercise

Re-run the demonstration level and try to follow the detailed instructions appearing on the screen. These give an insight into the ATC techniques employed. To help you follow the techniques you may use any of the special function keys.

The exercise starts with a completely empty radar screen and stack display. Aircraft are introduced one at a time at altitudes 7 and 8 (7000 and 8000 feet) at each individual stack in turn (these altitudes are used so that these aircraft are safely above any outbound aircraft which only climb to 6000 feet). Before they appear on the radar they are controlled by an en route controller, who also controls the outbound traffic, until such time as they can safely be put into the holding stacks at least 1000 feet above the next lowest aircraft. The exercise ceases at 15 mins and reverts to the menu of options.

5. Basic Vectoring, Slow Traffic - Level 1

In this exercise you are given all light aircraft and the objective is to establish them on the ILS and get them to land.

There are two stages to establishing an aircraft (a/c) on the ILS. Firstly, you must establish on the ILS centreline (called the localiser). To do this the a/c must have a heading of plus or minus 40 degrees from the runway heading as follows:

Direction	Runway Heading	Headings allowed
Schiphol Northerlies	010	330 to 050
Schiphol Southerlies	190	150 to 230

Heathrow Westerlies	280	240 to 320
Heathrow Easterlies	100	060 to 140

If the a/c actual heading is not within these limits the a/c will not establish. To get an a/c to establish you must append the letter 'E' to the end of the heading instruction e.g. "A Right » 240E". When the a/c is established on the localiser the letters 'loc' appear in the appropriate place in the stack display, and the a/c will turn to fly along the centreline.

The second stage of the approach is to establish the a/c on a sloping radio beam (called the glide slope) down which an a/c may fly to get to the runway. To establish on this beam you must be established on the localiser and at the same altitude as the beam at the point that you establish (as a guide the glide slope uses 300 feet for every mile from touchdown - thus at 10 miles you must be at or below 3000 feet.

The safest way to ensure that you establish an aircraft on the glide slope is to reduce the altitude to a level below the glide slope and fly along until the glide slope coincides with the a/c altitude. When established on the localiser and the glide slope the letters EST will appear on the stack display.

If the a/c establishes on the localiser but not on the glide slope, you may break off the approach once you have decided that it is too high by simply inputting a heading instruction. If you do not break off the approach the a/c will "GO AROUND" when overhead the airfield, this means the a/c will turn back to be repositioned

(and climb to 3000 feet if the a/c is below that). During the overshoot you do not have control of the a/c until it is heading back away from the airfield. You will be informed in the event box that "GO AROUND TOO HIGH" (remember to acknowledge using SPACEBAR and the abbreviation "Go Rnd" will appear on the stack dispaly.

N.B. When on the ILS all a/c like to reduce speed, and will not accept a speed above the Max ILS speed (see section 6). When the a/c gets to four miles fully established the a/c enters the "final approach" stage and will reduce speed. It ceases to be under your control at this point.

After 30 minutes or landing 10 a/c the exercises will cease and after reviewing the assessment you are given the option to start a new exercise or continue your present one for a further 30 minutes.

6. Mixed Traffic, Airspace Restrictions Level 2

In this level you have to deal with a mixture of aircraft types. This affects you in several ways. Firstly there is a speed differential between the various types and you must adjust the speeds accordingly to help your vectoring. Secondly the different types have different rates of descent to a suitable glide slope altitude. Lastly a/c will not establish on the localiser at more than their ILS maximum speed which is 40 knots above their minimum. Thus you must reduce a/c speed to at or below the ILS maximum speed

before they cross the centreline (like all other variables, speed changes are not instantaneous and you must allow good time for them).
The other concept introduced in this level is that of airspace restrictions. As the radar controller you are only entitled to use certain areas. You must keep your a/c on the radar at all times. Failure to do this will result in the message "-OUT OF RADAR COVER".
Also you may only descend the aircraft below 7000 feet when they are within an area called the Radar Manoeuvring Area (RMA). Descent below 7000 feet outside the appropriate area will result in the message "OUTSIDE AIRSPACE". To illuminate the RMA press keys "shift + R".
The minimum safe level is 2000 feet (to ensure at least 1000 feet above the highest obstacle in this area).
At Heathrow you have one extra constraint: You may not descend an aircraft below 3000 feet unless you are within 12 miles east or west of Heathrow. Failure to observe this will result in the message "LOW BELOW AIRSPACE".
Any airspace infringement will result in the loss of safety percentage points in accordance with how long the relevant aircraft was outside the allowed airspace.

7. Landing Interval and Separation - Level 3

Up to this stage the only criteria for landing safely has been safe establishment on the localiser and glide slope. However to ensure that each a/c remains safe, only one a/c is normally allowed on the runway at a time. Hence the

minimum time allowed between landing a/c is 1.5 mins (90 seconds). This equates to about 4 miles distance between a/c on the ILS but will vary with wind speed, direction and a/c type. To achieve the optimum landing interval experiment with different distances between successive landing a/c and refer to the events page to see the result in the landing times. If the interval between landing a/c is less than 1.5 minutes the a/c will "Go around" (as per Level 2) with the message "GO AROUND - SPACING" meaning the spacing on final approach was insufficient.

The other concept introduced here is perhaps the most fundamental and important part of air traffic control, that of the method of keeping a/c safely apart. There are two basic types of separation - vertical and radar. An a/c is vertically separated when it is at least 1000 feet above or below all other a/c in its vicinity. An a/c is radar separated when it is three miles or more from any other a/c.

You must ensure at all times that all a/c under your control are either vertically separated or radar separated. If two a/c under your control are less than 1000 feet vertically separated and less than 3 miles horizontally apart you will get the message "-NO SEPARATION WITH-" and the separation hooter will sound for three seconds. If the distance apart gets down to 1 mile or less yu will get the message "-COLLISION RISK WITH-" and the separation hooter will sound continously.

For each infringement of the separation rules you will lose safety marks for as long as the infringement exists. If two a/c collide you will fail the level!

8. Vortex Spacing, Outbound Aircraft Level 4

In this level you will see outbound and other traffic not under your control. They climb to a maximum of 6000 feet. You can identify this traffic by the SSR label displaying the a/c altitude only. You will see that some of the routes that the outbounds take go very close to or even across the inbound routes from the stack. It is still your responsibility to ensure that your a/c remain separated from the other traffic. Failure to do so will result in the message "NO SEPARATION WITH?".

When an a/c flies through the air, it creates a disturbance in the air similar to the wake of a boat in water. This is referred to as a Vortex wake. A Vortex wake affects a following a/c in proportion to the difference in size between the two a/c. It presents a hazard to the following a/c, especially at the latter stages of its approach and landing.

To mitigate this hazard minimum distances must be maintained as shown in the tables below. The distances and criteria used are different at Heathrow and Schiphol. At Schiphol, Vortex spacing is only required behind 'h' and 'c' types as follows

Aircraft following a type 'h' or 'c'

c	h	m	s	l
4 mi	4 mi	5 mi	5 mi	6 mi

At Heathrow vortex spacing is required between all types as follows

Leading type	Following type				
	c	h	m	s	l
c	4 mi	4 mi	5 mi	6 mi	8 mi
h	4 mi	4 mi	5 mi	6 mi	8 mi
m	3 mi	3 mi	3 mi	4 mi	6 mi
s	3 mi	3 mi	3 mi	3 mi	4 mi
l	3 mi	3 mi	3 mi	3 mi	3 mi

Remember that depending on the order in which you select a/c it is possible to radically change the average landing interval.
Failure to give enough spacing will result in a go around as in levels 2 and 3 and the message "GO AROUND VORTEX".

9. Emergency Traffic - Level 6

In this level one of your a/c will declare an emergency. You must land the a/c as soon as is possible. You are marked on the speed with which you land the a/c.

10. Additional Problem - Level 7

In this level not only do you have to contend with all the features of level 6, but also some other event will happen which may delay your traffic. The possible events are:
1) An unknown a/c will fly through your airspace. You must apply the normal rules of separation or you will lose safety marks.
2) One of your aircraft may lose contact with you (radiofail). You will only know that a radio failure

has occurred if you try to send an instruction and get the response "RTFAIL". The a/c will return into communication with you before very long.
3) Schiphol may lose a runway and you may have to go into Single Runway Operations. This means that the runway is being used for takeoffs as well as landings and therefore the minimum landing interval will increase to three minutes (180 secs), to allow one a/c to take off in between a/c which are landing.
4) Your SSR may fail, leaving you with the a/c blips only. All other equipment remains serviceable.

11. Random Problem with extra outbounds - Level 8

As exercise 7 with extra outbound traffic to avoid.

12. Summary Sheet

ATC	Aircraft Traffic Control
ILS	Instrument Landing System
SSR	Secondary Surveillance Radar
a/c	Aircraft

Radio Communication

A	- Altitude
R	- Right
Q	- Quote
S	- Speed
M	- Maintain
L	- Left
O	- Orbit

Aircraft Types and	Speed Ranges (knots)
c - concorde	190-300
h - heavy jet (Boeing 747)	160-250
m - medium jet (Douglas DC9)	160-250
s - small prop (Fokker F27)	140-210
l - light aircraft (Navajo)	120-180

Aircraft Heading and Direction Information

H - Holding in stack
loc - Localiser established
EST - Fully established
Go Rnd - Go Around
FinApp - Final Approach

Special Function Keys

"**SPACEBAR**":- Acknowledges incoming messages.
"**ENTER**":- Evaluates instruction.
"**DEL**":- Deletes line of instruction.
"←":- Freezes exercise until key "ENTER" is pressed.
"↓":- Slows down an exercise.
"↑":- Speeds up an exercise.
"**COPY**":- Holds exercise and displays a page of information on performance.
"**Shift** + **X**":- Abandons the exercise.
"**Shift** + **R**":- Puts the RMA lines on the screen for 12 seconds.
"**Shift** + **H**":- Goes to the Help pages.

Our policy is one of constant improvement. Therefore we reserve the right to modify any product without notice.

ERRATUM

In these instructions please substitute "CTRL" for "SHIFT"

Thus:
"SHIFT + X" should read "CTRL + X"
"SHIFT + R" should read "CTRL + R"
"SHIFT + H" should read "CTRL + H"

Please accept our apologies for this error

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